SATELLITE INDUSTRY ASSOCIATION

January 10, 2003

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W., Room TW-A325
Washington, D.C. 20554

Re: ***Ex Parte***
*In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, February 14, 2002

Dear Ms. Dortch:

The Satellite Industry Association ("SIA") hereby provides, in the above-captioned proceeding, the attached technical analysis entitled: "The Expected Signal Level Received at a Typical Earth Station due to Emission from an Ultra-Wideband Transmitter Operating in the 3700-4200 MHz Band." This technical analysis further supports SIA's position that implementation of the Commission rules for use of ultra-wideband ("UWB") devices would irreparably harm earth stations operating in the 3.7-4.2 GHz band ("4 GHz band").

SIA is a U.S.-based national trade association representing the leading U.S. satellite manufacturers, service providers, and launch service companies. SIA serves as an advocate for the U.S. commercial satellite industry on regulatory and policy issues common to its members. With member service companies providing a broad range of manufactured products and services, SIA represents the unified voice of the U.S. commercial satellite industry. SIA's Executive Members are: The Boeing Company; Globalstar, L.P.; Hughes Electronics Corp.; ICO Global Communications; Intelsat; Lockheed Martin Corp.; Loral Space & Communications Ltd.; Mobile Satellite Ventures; Northrop Grumman Corporation; PanAmSat Corporation; SES Americom, Inc.; and Teledesic Corporation. Inmarsat participates in SIA as a non-voting Associate Member.

SIA previously filed a petition for reconsideration in the above-captioned proceeding because the UWB rules adopted by the Commission would expose fixed satellite service ("FSS") systems operating in the 4 GHz band to harmful interference from UWB devices.[1] This *ex parte* filing, including the attached technical analysis,

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[1] *See* Petition for Reconsideration of Satellite Industry Association, June 17, 2002 ("Petition").

provides further support that UWB devices will cause harmful interference to FSS systems.

In particular, the attached technical analysis demonstrates that: (1) UWB devices, both dithered and non-dithered, operating in the 3700-4200 MHz band would cause harmful interference to earth stations operating in the same band; and (2) harmful interference would occur in every transponder across the 500 MHz band (3700-4200 MHz band). These findings match the determinations made by the National Telecommunications and Information Administration in the special publication that is cited in footnote 2 of the attached technical analysis. In addition, due to the particular characteristics of UWB devices, harmful interference not only occurs during the short pulse interval (the peak pulse period) in nanoseconds, but also occurs in the interval due to multipath reflection of the UWB signal as received at the earth station. Hence, if multipath reflection were taken into account, the effective harmful interference interval could be many times the actual UWB peak-pulse interval. The aggregate interference would be time additive for low pulse repetition frequency (e.g., 1 MHz), and time and power additive for high pulse repetition frequency (e.g., 100 MHz).

Accordingly, and particularly in light of the attached technical analysis, SIA urges the Commission to reconsider its decision regarding the operation of UWB devices in the 4 GHz band.

Sincerely,

/s/ Richard DalBello

Richard DalBello
Executive Director
Satellite Industry Association

Attachment

# The Expected Signal Level Received at a Typical Earth Station Due to Emission from An Ultra-Wideband Transmitter Operating in the 3700-4200 MHz Band

## 1. Introduction

In February 2002, the Federal Communications Commission (FCC) adopted a set of radio regulations for ultra-wideband (UWB) technology.[1] This regulation permits, without license from FCC, the marketing and operation of certain types of new radio transmitters incorporating low power UWB technology. In doing so, the FCC indicated that it was “proceeding cautiously” and implemented standards designed to protect authorized and licensed services from interference generated by UWB devices.

Prior to February 2002, FCC rules permitted similar levels of emission for unintentional (incidental) radiators in certain frequency bands above 960 MHz, including the 3700-4200 MHz band. The radiation from an incidental radiator is primarily spurious emission whereas the UWB radiator (i.e., transmitter) is intentional, that is, the radiation is fundamental emission. UWB devices operate by employing very-short duration pulses, in nanoseconds, that result in very wideband emission bandwidths, in GHz. The new FCC regulation limits the 10-dB emission bandwidth to no less than 500 MHz. The regulation specifies that UWB devices must not exceed an average field strength of 500 μV / m at 3 meters in a 1 MHz reference bandwidth or an equivalent average EIRP density of – 41.3 dBm / MHz in the 3.1 – 10.6 GHz band. The new rule also limits the peak EIRP density level of 0 dBm / 50MHz.

The objective of this study is to estimate the signal level from a UWB device as received by a typical earth station at a finite distance from the transmitter in the 3700-4200 MHz band. The study concludes that the UWB device will cause harmful interference to the receiving earth stations if the device is visible to the earth station, particularly during the peak EIRP time interval.

## 2. Approach

The study estimates the UWB signal level received at an earth station at a predetermined separation distance. The UWB signal level is assumed to be equal to an equivalent average EIRP density of – 41.3 dBm / MHz and / or a peak EIRP density of 0 dBm / 50MHz. The peak signal level density, SLD, received at the earth station antenna output is given by

$$SLD_{peak} = EIRP_{peak} - Lp + Gr(\theta) \qquad (1)$$

and the average signal level density received at the earth station is given by

$$SLD_{average} = EIRP_{average} + BWCF - Lp + Gr(\theta) \qquad (2)$$

where

$EIRP_{peak}$= the peak EIRP density

$= 0$ dBm / 50MHz

$EIRP_{average}$ = the average EIRP density

= - 41.3 dBm / MHz

Lp = the propagation loss (basic transmission loss) between the UWB device and the receiving earth station.

$Gr(\theta)$ = the earth station receiving antenna gain in the direction of the UWB

$= 32 - 25Log(\theta)$ dBi $1 < \theta < 48$

$= -10$ dBi $48 < \theta < 180$

$\theta$ = the off-axis angle between the earth station antenna boresight and the direction towards the UWB device, degrees

BWCF = the bandwidth correction factor (BWCF) to adjust the UWB average power density in 1 MHz to the IF bandwidth (50 MHz).

Since the UWB EIRP is a constant value for various very-short duty cycle pulse trains of certain pulse repetition frequency, it is necessary to determine the average power level at the earth station receiver having a typical IF bandwidth, for example, equal to 50 MHz. The bandwidth correction factor (BWCF) is a typical method of providing the conversion. The NTIA special publication[2] provides a detailed discussion of the procedure for calculating the BWCF for various UWB modulation types. According to the NTIA special publication, the equations are based on measurement and simulations and are normalized to the average (RMS) power level in a 1 MHz bandwidth. Hence, the equations provide a correction for the UWB signal average power level at the earth station receiver IF output. In addition, FCC also provided a graphical comparison of the difference in peak-to-average ratios of the UWB emission in Appendix E of the FCC Report and Order. An identical graph is also shown in the NTIA special publication.

The propagation model is based on a two-ray line-of-sight (LOS) model as shown in Figure 1 for a UWB transmitter height of 1.5 meter and an earth station antenna centerline height of 7.5 m. The break point for the two lines is at the distance between the transmitter and the receiver for which the ground just begins to obstruct the first Fresnel zone. Before the break point, the basic transmission loss is given by

$$Lp1 = 20Log(Freq) + 20Log(Dist) + 32.45 \quad \text{dB} \qquad (3)$$

and after the break point, the basic transmission loss is given by

$$Lp2 = 20Log(Freq) + 38.5Log(Dist) + 27.45 \quad \text{dB} \qquad (4)$$

The first segment, Lp1, is primarily due to the spreading of the electromagnetic wave in free space. However, when the first Fresnel zone starts to become blocked, attenuation in addition to the free space spreading results from the obstructing of the first Fresnel zone occurs. Consequently, a steeper path loss slope of 38.5 is found to fit this scenario. This is reflected in the second segment, Lp2. In order to have a smooth transition from Lp1 to Lp2 near the break-point, the analysis assumes the higher loss of either Lp1 or Lp2.

## 3. Analytical Result

The FCC UWB regulation specifies two power density limits: one is for average power density of –41.3 dBm / MHz; the other is for peak power density of 0 dBm / 50MHz. The following analysis complies with these limits, i.e., in no case does the UWB EIRP density level assumed in the analysis exceeds either the average or the peak power density limit. At the same time, the analysis is also consistent with the peak-to-average ratios given by FCC as contained in Appendix E of the FCC Report and Order. Figure 2 duplicates the graph for a resolution bandwidth (IF bandwidth) equal to 50 MHz.

Figure 3 shows typical results of an analysis for a single UWB device as it moves around a receiving earth station in a circle at a predetermined constant radius of 500 meters. The figure is for a UWB device at a height of 1.5 meters above ground level, an antenna centerline height of 7.5 meters above ground level and the earth station antenna elevation angle equal to 5 degrees. The UWB pulse repetition frequency (PRF) is 1 MHz and the pulse train is a dithered type. A dithered pulse sequence is a pulse position modulation technique with the pulses at a nominal average spacing of, for example, 1 microsecond (i.e., the reciprocal of 1 MHz).

The received peak power density level is depicted by the solid-red curve and the received average power density level is depicted by the dashed-dot blue curve. In addition, the earth station receiver noise floor level in a 50 MHz reference bandwidth is also plotted for comparison. The figure is for a circle-radius of 500 meters. At the satellite azimuth direction (i.e., azimuth angle equal to zero degrees), the earth station received an average UWB signal equal to 10 dB below the noise floor.

The summary results for an outdoor UWB device are contained in Table 1 for three antenna elevation angles (5, 10 and 15 degrees) and four PRF (0.1, 1.0, 10 and 50 MHz). This table only shows the separation distance when the UWB device is at the satellite boresight azimuth direction (i.e., azimuth angle equal to 0 degree) and the received signal level is equal to the earth station receiver noise floor. A blank entry stands for a separation distance of less than 50 meters.

**Table 1**
**Separation Distance between an Outdoor UWB Device[1] and a Receiving Earth Station[2] for the Assumed Condition that the Received Signal Level at the Earth Station is equal to the Noise Floor[3]**

| Earth station antenna elevation angle(deg) | UWB PRF (MHz) | **Separation Distance between One Outdoor UWB Device And a Receiving Earth Station** | | | |
|---|---|---|---|---|---|
| | | Non-dithered | | Dithered | |
| | | for average power density level | for peak power density level | for average power density level | for peak power density Level |
| 5 | 0.1 [4] | | 2.4 km | | 2.4 km |
| 10 | | | 1.35 km | | 1.35 km |
| 15 | | | 850 m | | 850 m |
| 5 | | 100 m | 2.35 km | 100 m | 2.35 km |

| | | | | | |
|---|---|---|---|---|---|
| 10 | 1.0 [5] | | 1.35 km | | 1.35 km |
| 15 | | | 830 m | | 830 m |
| 5 | 10 [6] | | 220 m | 100 m | 900 m |
| 10 | | | 90 m | | 380 m |
| 15 | | | 55 m | | 240 m |
| 5 | 50 [7] | | | 100 m | 520 m |
| 10 | | | | | 230 m |
| 15 | | | | | 140 m |

Notes:
1. The height of the UWB device is 1.5 meters above the ground level.
2. The height of the earth station antenna centerline is 7.5 meters above the ground level
3. The earth station receiver noise floor is:
   -99.9 dBm / 50 MHz at 5 degrees elevation angle
   -100.3 dBm / 50 MHz at 10 degrees elevation angle;
   -100.7 dBm / 50 MHz at 15 degrees elevation angle.
4. For non-dithered case, the average power density = – 51.0 dBm / MHz and the peak power density = 0 dBm / 50MHz.
   For dithered case, the average power density = – 51.0 dBm / MHz and the peak power density = 0 dBm / 50MHz.

5. For non-dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -0.3 dBm / 50MHz.
   For dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -0.3 dBm / 50MHz.

6. For non-dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -20.3 dBm / 50MHz.
   For dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -10.3 dBm / 50MHz.

7. For non-dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -34.4 dBm / 50MHz.
   For dithered case, the average power density = – 41.3 dBm / MHz and the peak power density = -14.3 dBm / 50MHz.

Table 2 summarized the results for an outdoor UWB device in a similar environment except that the received signal level is 10 dB below the earth station receiver noise floor.

**Table 2**
**Separation Distance between an Outdoor UWB Device[1] and a Receiving Earth Station[2] for the Assumed Condition that the Received Signal Level at the Earth Station is equal to 10 dB Below the Noise Floor[3]**

| Earth station antenna | UWB | **Separation Distance between One Outdoor UWB Device And a Receiving Earth Station** | |
|---|---|---|---|
| | | Non-dithered | Dithered |

| elevation angle (deg) | PRF (MHz) | for average power density level | for peak power density level | for average power density level | for peak power density level |
|---|---|---|---|---|---|
| 5 | 0.1 [4] | 110 m | 4.4 km | 100 m | 4.4 km |
| 10 | | | 2.9 km | | 2.9 km |
| 15 | | | 2.3 km | | 2.3 km |
| 5 | 1.0 [5] | 520 m | 4.4 km | 500 m | 4.4 km |
| 10 | | 230 m | 2.9 km | 230 m | 2.9 km |
| 15 | | 140 m | 2.3 km | 140 m | 2.3 km |
| 5 | 10 [6] | 100 m | 850 m | 520 m | 2.4 km |
| 10 | | | 380 m | 230 m | 1.3 km |
| 15 | | | 240 m | 140 m | 820 m |
| 5 | 50 [7] | | 100 m | 520 m | 1.9 km |
| 10 | | | | 230 m | 820 m |
| 15 | | | | 140 m | 500 m |

Notes:

1. The height of the UWB device is 1.5 meters above the ground level.
2. The height of the earth station antenna centerline is 7.5 meters above the ground level.
3. The received signal level at the earth station is equal to:
   - - 109.9 dBm / 50MHz at 5 degrees elevation angle
   - - 110.3 dBm / 50 MHz at 10 degrees elevation angle
   - - 110.7 dBM / 50 MHz at 15 degrees elevation angle

4. For non-dithered case, the average power density = - 51.0 dBm / MHz and the peak power density = 0.0 dBm / 50MHz.
   For dithered case, the average power density = - 51.0 dBm / MHz and the peak power density = 0.0 dBm / 50MHz.

5. For non-dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 0.3 dBm / 50MHz.
   For dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 0.3 dBm / 50MHz.

6. For non-dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 20.3 dBm / 50MHz.
   For dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 10.3 dBm / 50MHz.

7. For non-dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 34.3 dBm / 50MHz.
   For dithered case, the average power density = - 41.3 dBm / MHz and the peak power density = - 14.3 dBm / 50MHz.

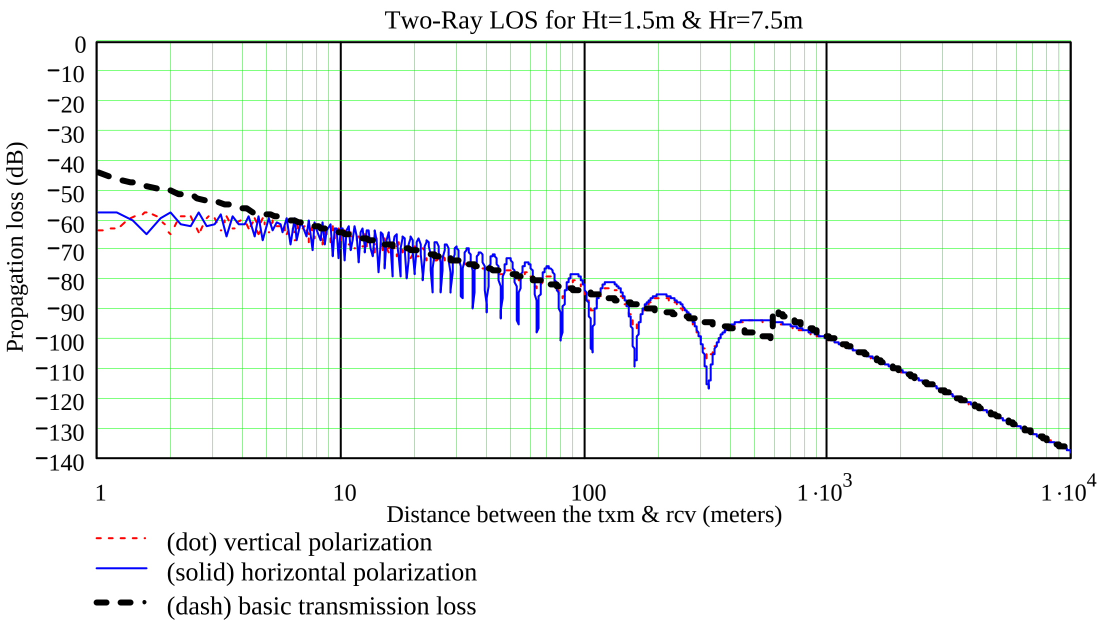


Figure 1 Two-Ray Line-Of-Sight (LOS) Propagation Model for a UWB Height of 1.5-m and an Earth Station Antenna Center-Line Height of 7.5-m

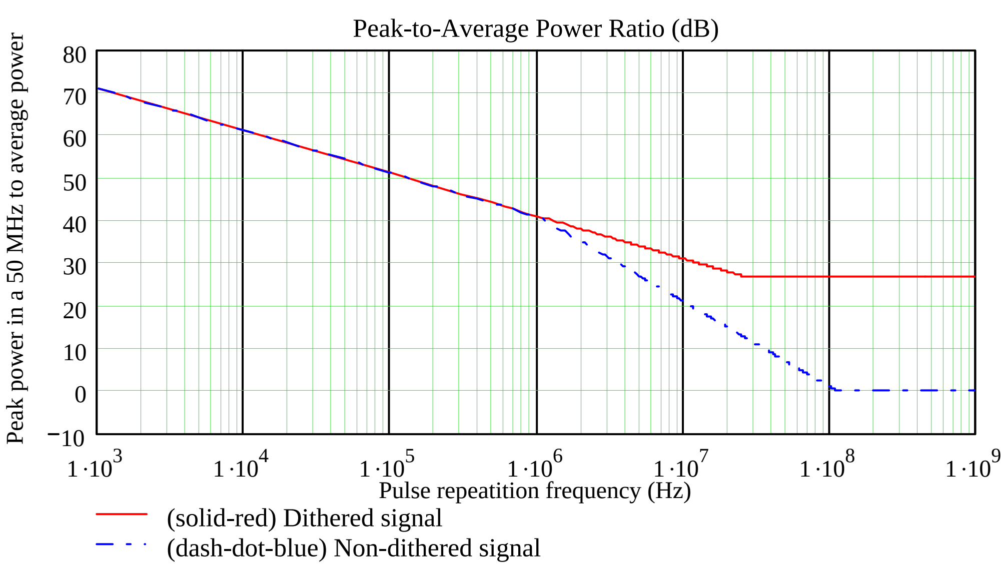


Figure 2 Peak Power in a 50 MHz Bandwidth –to– Average Power

in a 1 MHz vs. PRF

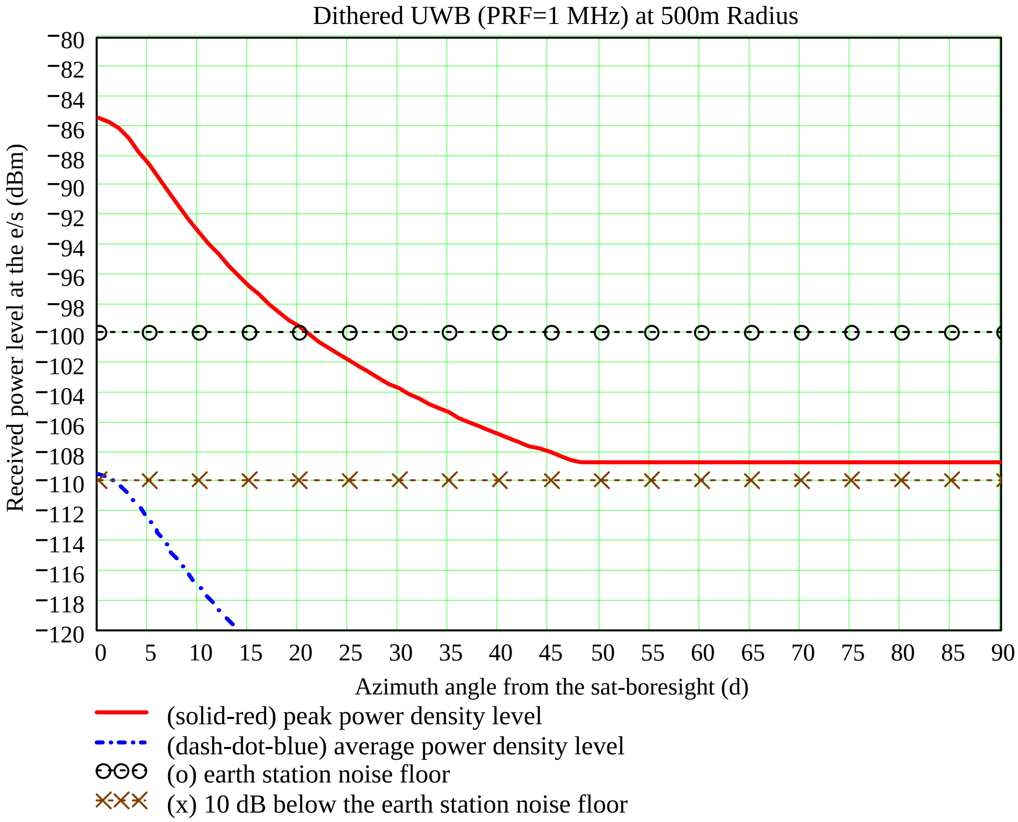


**Figure 3 The Expected Received Signal Level at the C-band Earth Station due to One Outdoor Dithered UWB Device Moving Around the Earth Station At a Constant Radius of 500 m**

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[1] In the matter of Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-153, 14 February 2002, Federal Communications Commission, USA.

[2] L. K. Brunson et al, “Assessment of Compatibility between Ultrawideband Devices and Selected Federal Systems,” U.S. Department of Commerce, National Telecommunications and Information Administration (NTIA), NTIA Special Publication 01-43, January 2001.